Editorial Commentary

The importance of preoperative imaging in living-donor hepatectomy

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Liver transplantation (LT) is the best treatment for end-stage liver disease and primary liver malignancy. In the eastern part of the world, most LT procedure are performed from a living donor graft. Consequently, the living-donor hepatectomy (LDH) is one of the most important and complex procedure since it can both impact donor and recipient outcomes. Indeed, excessive hilar plate dissection should be avoided in order to prevent biliary leakage but on the counterpart identification of the arterial anatomy is crucial before its section in order to avoid accidental arterial injuries that could lead to dramatic consequence for liver vascularization in both donor and recipient.

In this perspective, Kusakabe and colleagues (1) report two cases of accidental arterial section secondary to early arterial division during a donor right lobectomy (case 1) and a right posterior sectionectomy (case 2). In the first case, no consequences were observed while in the second, the accidental arterial section led to ischemic cholangitis with refractory biliary tract stenosis. Related to these two observations, the authors retrospectively analyzed 500 preoperative imaging of living donor or pancreaticoduodenectomy using a three-dimensional (3D) reconstruction software allowing to visualize both vascular and biliary anatomy so called "all in one" 3D imaging.

Based on their observations, the authors reported a functional classification of the right posterior sector graft according to the presence or not of an early arterial bifurcation defined as the proximity between root of the right hepatic duct (i.e., the estimated cutting line) and the bifurcation of right hepatic artery (RHA) into the right anterior hepatic artery (RAHA) and right posterior hepatic artery (RPHA). Two groups were defined according to the course of the RPHA caudally (so called "infra-portal", group 1) or cranially (so called "supra-portal", group 2) to the right portal vein. Both groups were further divided in two subgroups according to presence or not of an early bifurcation. A third group (group 3) was also described when RHA directly branched of A6/A7 separately and was considered as systematically presenting early bifurcation.

The author's findings showed the insidious difficulty to recognize an early bifurcation on conventional pre-operative imaging but also during the surgical procedure although an early arterial bifurcation was retrospectively identified in 35.3%, 0%, and 100% of cases in groups 1, 2, and 3,

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respectively. Consequently, misrecognition of an arterial bifurcation is a risk factor of accidental hepatic artery (HA) injury leading to potential ischemic cholangiopathy.

These findings represent important data and certainly, the variability of hilar anatomy is even more complex with many possible variations (2), and directly impact the arterial anastomosis (3), but the classification proposed by the authors is simple and practical for LDH procedure.

On the other hand, the surgical procedure for LDH is more and more turning towards to a minimally invasive approach especially with the robot assisted procedure. In this context, the "all in one" 3D imaging proposed by the authors combined with the new technologies such as virtual reality, augmented realty, mixed reality or extended reality will probably be the standard of care in upcoming years since the use of the information generated by 3D virtual scenarios in real-time surgery using increased reality technology will be rapidly developed (4). Different studies, already proposed minimally invasive liver surgeries assisted by virtual imaging. A hyper accuracy 3D imaging has been reported to navigate patient's anatomy with the possibility to visualize selectively the different vascular and biliary structures of the liver (5). In the above-mentioned study, the authors used an intraoperative navigation device for intraoperative 3D visualization technology (3DVT) evaluation. This device allowed the surgeon to manipulate 3DVT using a touchless system during surgery, to identify the principal vessels, help decreasing the risk of complications. In the last few years, technology has been developing new software to analyze pre-operative radiological images. Likewise, the HoloLens2® is an optical see-through head-mounted display that enables the projection of virtual content onto the user's real-world field of vision allowing the surgeon to compare the hologram with the images predicted and observed from the laparoscopic monitor (6). Thus, this technology allows to visualize the structure to be resected or not with the awareness of the actual surgery.

Robotic surgery in the transplant field is widely used for all abdominal organs (7). Using the new virtual reality models combined with the robotic console, surgeons will be able to precisely identify the anatomy and then reduce accidental injury during a surgical procedure such as LDH.

In summary, LDH is a very complex procedure. In their study, Kusakabe *et al.*, recommend to systematically identify vascular and biliary anatomy using an "all-in-one" 3D imaging and proposed a practical classification in order to avoid accidental arterial injuries and its consequences.

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